# UPSIDE-DOWN FLIES

## Their History and Natural History

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There are some groups of animals, such as birds, butterflies and mosquitoes, which have attracted detailed study over many years, and have become so well known that discovery of new species seldom happens now. Then there are groups, the Cinderellas of the animal kingdom, which have been given very little attention. Among the latter are most of the smaller flies, in fact one genus of flies has been named *Cinderella*. There must be many thousands of fly species yet to be named and described, especially in south-east Asia, Africa, and the Southern Hemisphere generally, and the few specialists in this field are repeatedly making new discoveries.

LIVING upside-down flies (genus *Neurochaeta* of the family Neurochaetidae) were described for the first time and their family status established only nine years ago (McAlpine 1978), though fossil forms at least 40 million years old were known earlier (Hennig 1965). These fossil flies are preserved in amber, the hardened resin of coniferous trees which grew in northern Europe at about the end of the Eocene period or the beginning of Oligocene period. When the resin was still fluid, various insects and other objects of the ancient forest became stuck and encased in it.

The modern species are from the warmer parts of the old world, the five already described living in Zimbabwe (Rhodesia), Madagascar, Australia, Malaysia and the Philippines (McAlpine 1978; Woodley 1982). A couple of years ago Kay Chye Khoo and I discovered two additional species in West Malaysia not far from Kuala Lumpur, and only last year John Ismay found another in the highlands of Papua New Guinea. It appears now that South-east Asia, with four of the eight known species, may have the greatest representation of the genus *Neurochaeta*, though this picture could change with further collecting in other countries.

At this stage I should explain how these little flies received their common name. If resting on a vertical or nearly vertical surface the fly is always positioned with the head pointing downwards. The insect can run rapidly, for its size, in any direction, but it does this without turning its body from the head downwards positions. Thus it must run backwards to go upwards, sideways to go horizontally, and forwards only if going downhill. Of course if it is on a horizontal surface these rules do not apply, the insect's body being simply parallel to the surface, and it flies head first in a normal horizontal position. An interesting experiment is to place a number of upside-down flies in a small jar. All those on the vertical glass surface will then have their heads directed downwards. The container is then inverted, and each fly immediately turns to restore its original position.

The upside-down flies are not of imposing appearance, and, in the field, are most easily recognised by their behaviour. They are slender, more or less flattened flies measuring about two or four millimetres long, the colouring being a combination of pale cream and blackish brown or grey. In the Asian and Australian species there are characteristic bristles arising from the upper surface of one of the veins near the middle of the basal half of each wing. When the wings are folded flat over the abdomen, these bristles point upwards. The presence of these bristles can be used to sort the flies from others of similar appearance, but of course good magnification is needed to see such details in flies of this size.

Details of the life cycle are known only for the Australian upside-down fly (*Neurochaeta inversa*), but these are outlined here because they may be similar in one of the Malaysian species.

The host plant of the Australian fly (and also of *Neurochaeta macalpinei* from Sabah) is the cunjevoi or badiang (*Alocasia macrorrhiza*). The adult flies have been seen feeding on the pollen of the cunjevoi, and even robbing the small stingless bees which have gathered pollen on to their legs. When the plants are not in flower they must find other food, probably fallen items caught on the large leaves of the *Alocasia*, as they spend almost their whole lives on these plants.

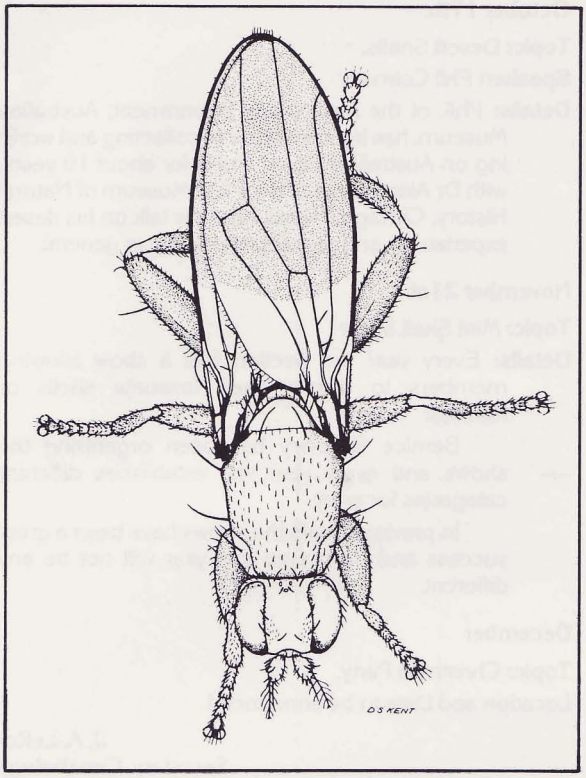
Cunjevoi or badiang (*Alocasia macrorrhiza*), the host plant of *Neurochaeta inversa* in Australia and *Neurochaeta macalpinei* in East Malaysia.

*Alocasia*, being a member of the arum or calla lily family (Araceae), has the minute flowers crowded on a rod-like spadix. The female (seed-producing) flowers are on the lower part of the spadix which is loosely enclosed by the leaf-like spathe. The female fly lays eggs on the female flowers and the newly hatched larvae live among the little green fruits which develop from the flowers. By this time the lower part of the spathe has formed a sealed chamber in which fruits and larvae can develop in protection from the outside world. As the larvae does not damage the fruits, it probably eats microscopic organisms living in the watery liquid trapped in the chamber. Like many flies, the larva does not shed its skin when pupating, but the larval skin hardens to form a puparium which enloses the delicate pupa. When the fruits are ripe and red, the spathe splits open and the adult fly, now emerging from the pupa, can escape.

There are no records of the habits and behaviour of the upside-down flies of Zimbabwe, Madagascar and the Philippines, and until recently *Alocasia* was the only known host plant for the group. It is therefore of considerable interest that the three recently discovered species were each consistently associated with another plant, wild ginger for one and wild banana for the other Malaysian species, and pandanus (screw palm) for the New Guinea species. As only adult flies were found, it is not yet known if the whole life cycle is as intimately tied up with the host plant as it is in the Australian *Neurochaeta inversa*. This discovery opens up the possibility of there being several other species of upside-down flies in tropical Asia, each with its own host plant. The most suitable plants would seem to be those that trap water in their leaf bases or bracts forming little sheltered pools (called phytotelmata) in which a variety of small animal-life can live.

We have now found out enough about upside-down flies to attempt an answer to the question: Why are upside-down flies so different from other flies? Firstly, they are adapted for efficient running and infrequent flying, and, secondly, they are adapted for sheltering in narrow, confined spaces.

Anyone who has tried to capture these flies when they are moving freely on the plant surface will realise how effective running in rapid zigzags can be as a means of avoiding enemies. However, if persistently pursued, the flies take to the wing, and flight is presumably used for dispersal to other plants. It is obvious that an insect which remains head downwards and moves about the surface of the plant for long periods must move backwards about as much as it moves forwards, or it would only be able to work its way to the lowest part of the plant and stay there. So running backwards (when going uphill) is a peculiar aspect of the upside-down flies' behaviour. Microscopic




The Australian upside-down fly (*Neurochaeta inversa*) occurs at rain forest margins from north of the Hunter River to the Atherton Tableland. Length c. 3 mm.

study of the flies suggests that they are specially constructed to run into things backwards without injury, having what appear to be organs of touch on the wing-tips and tip of the abdomen, and the wing-tip also shows an unusual degree of strengthening.

The recently discovered upside-down fly from the highlands of Papua New Guinea (mentioned above) is the largest of the family with a head and body length of about 6 mm. It is well protected on its host plant, a species of *Pandanus* (a palm-like plant) with formidable spikes on the leaf margins. When disturbed it prefers running down into the leaf-bases to flying.

The different species of upside-down flies have different degrees of body-flattening associated with a sideways splaying of the legs, which enable them to creep into crevices. This is noticeable in a Malaysian species which has been seen entering the narrow cavity inside a bract of the wild ginger (*Zingiber spectabile*), but is extreme in the New Guinea species mentioned above. The bristles on the upper surface of the wing are presumed to be sensory and the fly can be instantly aware of touching a low ceiling. It need never get stuck.

Perhaps all these unusual features contribute to one outstanding but little-documented attribute of upside-down flies — their longevity as adult flies. For the Australian species there is reasonable evidence that the adults can live for six months or more, and there is some reason to believe that Malaysian species may also be long-lived.

As upside-down flies appear only to live in or at the margins of rainforests, they will cease to live their long lives unless the forests are preserved.

## REFERENCES

HENNIG, W., 1965. Die Acalyptratae des Baltischen Bernsteins. Stuttgart. Beitr. Naturk. **145:** 1-215.

MCALPINE, D. K., 1978. Description and biology of a new genus of flies related to *Anthoclusia* (Diptera, Schizophora, Neurochaetidae). *Ann. Natal Mus.* **23:** 273-395.

MCALPINE, D. K., in press. Studies in upside-down flies (Diptera, Neurochaetidae). Proc. Linn. Soc. NSW.

WOODLEY, N. E., 1982. Two new species of *Neurochaeta* McAlpine (Diptera, Neurochaetidae), with notes on cladistic relationships within the genus. *Mem. ent. Soc. Wash.* **10:** 211-18.

Diagram of the inflorescence of *Alocasia*, in which the immature stages of *Neurochaeta inversa* are passed.